

Standard Test Method for Critical Diameter and Detonation Velocity of Liquid Monopropellants¹

This standard is issued under the fixed designation D 2541; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method² covers the evaluation of two properties of a high-energy liquid propellant. In one form, the critical internal diameter is determined in a given type of metal or plastic tubing below which propagation of stable high-velocity detonation will not take place. In the alternative form, which uses more material, detonation rate is concurrently measured. The composite donor of either size may be used in most instances to initiate detonation in experimental trap designs.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Terminology

2.1 Definition:

2.1.1 *critical diameter*—the largest diameter that will not detonate when the donor is exploded.

3. Summary of Test Method

3.1 Various diameters of tubing are filled with propellant, and an attempt is made to cause the propellant to detonate by use of a secondary detonating medium (the donor).

4. Significance and Use

4.1 It should be emphasized that the critical diameter, as determined under these conditions, is valid only for these conditions and is not an intrinsic property of the sample. One vital parameter in establishing the critical diameter is that of confinement of the test specimen. The fact that detonation occurs or does not occur in Type 347 stainless steel tube does

not necessarily imply that the same results would be obtained in an aluminum, copper, glass, etc., tube of similar dimensions. Type 347 stainless steel tube is acceptable for a standard reference test, but for practical application, diameters should be studied in the materials and wall thicknesses proposed for use.

4.2 When working with high-energy liquid propellants, serious consideration shall be given to the possibility that a detonation originating in the engine can propagate upstream to the propellant tank and cause a disastrous explosion. Therefore, it is useful to know the minimum diameter of propellant line through which a detonation of the propellant in question can propagate. If it is impracticable to use propellant lines smaller than this minimum, it will be necessary to design and test detonation traps in larger lines. The minimum or critical diameter (often referred to as “failure” diameter), when the conditions are properly defined, can be a useful measure of the shock sensitivity of similar systems. The detonation velocity of the propellant in question is another property of interest.

4.3 The three determinations, namely: minimum diameter for propagation, detonation trap requirements, and detonation velocity, have much in common; all presuppose the initiation of a stable detonation in a liquid contained in a tube. The key to the present test method is the use of a donor stage consisting of the material under test. Although a compound initiator comprised of a blasting cap and high-explosive booster is employed, the true donor is a length of the subject material sufficient to assure establishment of a stable detonation characteristic of the test medium ahead of the first test section or measuring station. Questions of wall and boundary discontinuity are thereby eliminated along with the accompanying complications of impedance mismatch and perturbation of the shock front.

5. Apparatus

5.1 The liquid under test, depending on what measurement or measurements are to be made, shall be contained in one of the following three assembled units:

5.1.1 *Assembly No. 1, Critical Diameter Measurement (Fig. 1 (a)):*

5.1.1.1 Section A, Fig. 1 (a), shall consist of Type 347 stainless steel tubing (1-in. (254-mm) outside diameter by 0.049-in. (1.24-mm) wall thickness by 6-in. (152-mm) length). When filled with test sample, it is considered the “self donor” section.

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace Industry Methods and is the direct responsibility of Subcommittee F07.02 on Propellant Technology.

Current edition approved March 15, 1993. Published May 1993. Originally published as D 2541 – 66 T. Last previous edition D 2541 – 83.

² This test method is identical in substance with the JANNAF method, “Critical Diameter and Detonation Velocity Test,” Test Number 8, Liquid Propellant Test Methods, May 1964, published by the Chemical Propulsion Information Agency, Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Rd., Laurel, MD 20707.